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Caesarean section in Malawi: preventable factors in maternal and perinatal mortality

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ABSTRACT

OBJECTIVES: To examine factors that may influence maternal and perinatal mortality associated with caesarean section in an African country.

DESIGN: A prospective observational study, conducted between January 1998 and June 2000, of 8070 caesarean sections.

SETTING: 25 district and 2 central hospitals in Malawi.

Main outcome measures. Association between hospital type, ward or operative care, training of surgical and anaesthesia personnel, preoperative complications, method of anaesthesia, blood loss and anaesthetic technique on maternal and perinatal mortality.

RESULTS: Questionnaires were returned for 5236 caesarean sections in district and 2834 in central hospitals. 95% were emergencies, 65% for obstructed labour. Pre-operative haemorrhagic shock was present in 7.6% of women, anaemia in 6.2% and ruptured uterus in 4.1%. Previous cae-

sarean section did not appear to predispose to ruptured uterus. There were 85 maternal deaths (1.05% mortality), 65 of which occurred postoperatively on the wards. Maternal mortality was increased with ruptured uterus (adjusted odds ratio 3.9, 95% CI 2.3-6.5), little anaesthetic training (2.3, 1.3 to 4.1) and blood loss requiring transfusion (19.3, 9-41). In mothers without preoperative haemorrhage spinal anaesthesia was associated with lower maternal mortality than general anaesthesia (0.23, 0.1-0.7). Perinatal mortality was 11.2% overall, and was significantly associated with ruptured uterus, halothane and ketamine anaesthesia.

CONCLUSION: Maternal and perinatal mortality rates among women undergoing caesarean section in Malawi are high. Improving resuscitation in postoperative wards might reduce maternal mortality. Blood loss and pre-operative complications are both strongly associated with mortality. Spinal anaesthesia was associated with good outcome.

Introduction.

Caesarean section is the commonest major surgical procedure in Africa.¹ The caesarean section rate is approximately 9% at the central hospitals and of the order of 1% in rural areas of sub-Saharan Africa^{2,3}. Most caesarean sections are performed as emergencies without pre-operative preparation. Anaemia, hypovolaemia and sepsis from obstructed labour and ruptured uterus are common. Despite its importance there are few published data on caesarean section in Africa⁴, and published studies are either small⁵ or retrospective⁶. Caesarean section is associated with a significantly higher mortality for both mother and baby in Africa than in industrialised countries. The overall maternal mortality rate (MMR) in Malawi has been reported as between 420 and 620 deaths per 100 000 pregnancies,⁷ recently 1120/100,000⁸ compared to around 10 per 100 000 in developed countries. As caesarean section is so common, even modest improvements could have an impact on maternal mortality.

This study was designed to identify potentially modifiable risk factors for maternal mortality in central Africa during or following caesarean section. It was a multi-centre prospective study involving both rural and central hospitals. The study had four primary objectives. The first was to examine whether mortality was mainly in the peri-operative period or postoperatively on the wards. The second was to explore differences between outcomes in rural and central hospital and the impact of level of training of surgeons and anaesthetists. The third was to examine causative factors, including blood loss and the use of transfusion. Blood is hard to obtain, and in an area of high HIV incidence, even screening may fail to detect infection. The fourth was to determine whether anaesthetic method affected mortality. Proposals for change would have to take account of the limited resources

in sub-Saharan Africa: for example the per-capita health expenditure in Malawi is US\$ 3-4 per annum, whilst HIV seroprevalence in pregnant women in urban areas is 34%.⁹

Methods

The course and outcome of caesarean sections performed between January 1998 and June 2000 in 27 hospitals in Malawi (2 central and 25 district) were recorded prospectively. A caesarean section was defined as any operation to deliver the baby per abdomen, whether live or not, after 28 weeks gestation, including surgery for ruptured uterus. Each anaesthetist completed data forms reporting on at least 10 consecutive caesarean sections that came under his/her management. Data recorded included indication for caesarean section, number of previous caesarean sections, pre-operative complications such as anaemia or fever, status and training of anaesthetists and surgeons, estimated blood loss, overall need for blood transfusion, type of anaesthesia and the use of cricoid pressure during tracheal intubation. Major outcomes were death during induction, maintenance or recovery from anaesthesia and surgery and up to 72 hours postoperatively on the ward. Birth outcome and the survival of the baby at 72 hours were also recorded.

One of us (PF) trained each participating anaesthetist in observation and recording the required operative and postoperative events, then checked the data sheets against hospital theatre records during routine district visits where possible. If it was considered that one or more records in a batch of 20 might inaccurately represent operating theatre events or had been completed retrospectively, all records in that batch were rejected and the anaesthetist given further training. When records were repeatedly unreliable the source was not included in the study.

The data were entered into EpiInfo version 6. Statistical analysis was performed using STATA 5 (StataCorps 1997). Skewed data were compared using Wilcoxon rank-sum analysis. Odds ratios were calculated uncorrected, and all potential confounding factors tested by logistic regression. Where they were found to cause confounding they were included in the final model.

Results

Reports were accepted for 8070 operations, of which 2834 (35%) were performed in the two central hospitals. Ninety five percent of all operations were emergencies. The indication was related to obstructed labour in 65% of all caesarean sections, similar in both urban and rural areas. Fetal distress (11%), ante partum haemorrhage (4.8%) and preeclampsia (3.3%) were less common indications. The most common pre-surgical complications were haemorrhagic shock (8.7% of rural and 5.5% of urban cases), anaemia (7.1% of rural and 4.5% of urban cases) and ruptured uterus.

Data were accepted from 45 anaesthetists, all of whom were paramedicals. In 703 of the caesarean sections, anaesthesia was provided by individuals who had received on-the-job training but no formal anaesthetic training. Surgeons were paramedicals (65.1% of operations), intern doctors (21.5%), registrars (4.0%), general doctors (6.1%) or specialists (3.2%).

There were 85 maternal deaths (mortality rate 1.05%) overall. Fifteen deaths occurred on the operating table, 2 in recovery and 68 on the wards. Of those who died on the wards, 58 mothers (68% of all deaths, 85% of the ward deaths) died in rural hospitals between the first and third postoperative days.

Ruptured uterus was present in 333 mothers, 35 of whom died (41% of deaths); 70% of all women and 80% of those who died had had no previous caesarean section (Table 1).

Table 1. Previous caesarean section and death from ruptured uterus

| | total | ruptured uterus | | Deaths from |
|----------------|-------|-----------------|----------|-------------|
| | | n(%) | deaths | all causes |
| Previous CS | 2442 | 88(3.6%) | 7 (8%) | 17 (0.7%) |
| No previous CS | 5628 | 245 (4.4%) | 28 (11%) | 68 (1.2%) |
| All | 8070 | 333 (4.1%) | 35 (11%) | 85 (1.1%) |

Previous caesarean section was not associated with increased risk of ruptured uterus or death. Other complications contributing to mortality in the opinion of the attending anaesthetist were: intraoperative hypotension (75.3% of deaths), operative haemorrhage (53%), ventilation difficulty (14%), regurgitation of stomach contents (13%) preeclampsia (8%) and difficult intubation (1%). In 76.5% of cases in which the mother died, the baby died also. In all caesarean sections, 3-day survival of the baby was 89.5%.

The numbers of maternal and perinatal deaths by hospital type, training of surgeon and anaesthetist and anaesthetic method are given in Table 2, and odds ratios, unadjusted and adjusted for potential confounding factors in Table 3.

The 'other' anaesthetic methods include halothane given by mask only (12 operations, no deaths) and local block (7, no deaths). Twenty of those given ketamine were not intubated, two of whom died. Variables found to be important potential confounding factors and incorporated in the model are pre-existing medical problems, indication for caesarean section, surgical experience and district/central hospital. Since pre-operative haemorrhage and hypotension are contraindications to spinal

anaesthesia the comparison of inhalation with spinal anaesthesia is restricted to those mothers in whom haemorrhage and hypotension were not present. In this group only 7 deaths occurred on the operating table or in recovery, with the remainder on the wards.

Table 2. Numbers of caesarean sections in different categories, with maternal and perinatal mortality rates.

| | Number of caesarean sections | Maternal deaths n (%) | Perinatal deaths n (%) |
|------------------------------|------------------------------|-----------------------|------------------------|
| Rural hospitals | 5236 | 68 (1.3) | 710 (13.6) |
| Urban hospitals | 2834 | 17 (0.6) | 197 (7.0) |
| Medically qualified surgeon* | 1075 | 14 (1.3) | 161 (15.0) |
| Intern doctor | 1739 | 4 (0.23) | 64 (3.7) |
| Clinical officer surgeon | 5256 | 67 (1.3) | 682 (13.0) |
| Trained anaesthetist | 7367 | 68 (0.9) | 823 (11.2) |
| Untrained anaesthetist | 703 | 17 (2.4) | 84 (12) |
| Spinal anaesthesia | 3136 | 4 (0.13) | 141 (4.5) |
| Inhalation anaesthesia | 4753 | 59 (1.2) | 652 (13.7) |
| Ketamine | 158 | 20 (20.0) | 108 (68) |
| Other anaesthetic methods | 23 | | |

*Specialist surgeons, registrars and general doctors, but excluding intern doctors

Regurgitation of stomach contents was reported in 142 patients (11 of whom died), but occurred at intubation in only 66, seven of whom died. Cricoid pressure was applied in 60% of all general anaesthetics, and in all seven of those who died following regurgitation at induction of anaesthesia. Examination of the recorded clinical events (by PF) showed that regurgitation was a direct or probable contributing cause of death in 8 mothers, all of whom had other coexisting serious complications such as sepsis, shock or anaemia. Postoperative aspiration pneumonia was reported in only one mother who regurgitated during anaesthesia but did not have any other pre-operative complication.

Anaesthetists estimated how much blood was needed in complicated operations, and recorded how much blood was given. The numbers of deaths at each level of deficit are given in Table 4. There was a strong association between increasing blood deficit and mortality (χ^2 for trend up to 3 units 1041, $P < 0.0001$). There was a blood deficit of 2 or more units in 53% of those who died, and in 1.6% of those who survived. The odds ratio (OR) for death in those with more than 2 units deficit was 68 (95% CI 43-108). After adjusting for pre-existing medical complications (excluding haemorrhage), central or rural hospital and surgeon experience, the OR is 22.1 (95% CI 12.8-38). The OR for maternal death among those needing 2 or more units of blood whether or not it was available was, however, 55.1 unadjusted (95% CI 32-93), and 22.2 (9.7-42) adjusted (95% CI 9-41). Participating centres made more exact estimates of blood loss in the last 5198 consecutive cases. In these median estimated intraoperative blood loss was 800 ml (interquartile range 350-1200) in those who died, 300 ml (250-450) in those who did not ($P < 0.0001$). In only 46% of cases was the estimated requirement for blood transfusion actually given, either in theatre or up to 72 h postoperatively.

Adjusted odds ratios show that perinatal mortality was increased in the presence of ruptured uterus, halothane compared with ether anaesthesia, and ketamine compared with all inhalational anaesthesia, and was reduced with spinal anaesthesia (Table 3).

Table 3. Odds ratio of maternal death overall, perioperative death, fetal complications and severe non-fatal complications, unadjusted and adjusting for possible confounding factors.

| | Unadjusted OR (95% CI) | Adjusted OR (95%CI) | P |
|--|------------------------|---------------------|--------|
| Rural hospitals compared to central hospitals | | | |
| Maternal death | 2.1 (1.2-3.7) | 0.8 (0.9-2.7) | 0.5 |
| Perinatal death | 2.1 (1.8-2.5) | 1.3 (1.0-1.6) | 0.08 |
| Ruptured uterus compared with other indications | | | |
| Maternal death | 18.1 (11.5-28.3) | 3.9 (2.3-6.5) | <0.001 |
| Perinatal death | 68.0 (49-93) | 36.5 (26-51) | <0.001 |
| Clinical officer surgeons compared to medically qualified surgeons | | | |
| Maternal death | 1.0 (0.5-1.7) | 1.1 (0.5-2.0) | 0.9 |
| Perinatal death | 1.7 (1.4-2.0) | 1.2 (0.9-1.5) | 0.2 |
| Untrained anaesthetists compared with trained anaesthetists. | | | |
| Maternal death | 2.7 (1.6-4.6) | 2.3 (1.3-4.1) | 0.004 |
| Perinatal death | 1.1 (0.8-1.4) | 0.94 (0.7-1.2) | 0.6 |
| Halothane (n=3124) compared with ether (n=1629) | | | |
| Maternal death | 1.2 (0.7-2.1) | 0.78 (0.4-1.4) | 0.4 |
| Perinatal death | 1.3 (1.1-1.5) | 1.3 (1.06-1.6) | <0.01 |
| Spinal anaesthesia compared with inhalation general anaesthesia | | | |
| Maternal death | 0.10 (0.04-0.3) | 0.23 (0.1-0.7) | 0.006 |
| Perinatal death | 0.48 (0.4-0.6) | 0.50 (0.4-0.6) | <0.001 |
| Ketamine compared with inhalation anaesthesia (ether + halothane) | | | |
| Maternal death | 11.9 (6.8-20.9) | 2.9 (1.5-5.2) | <0.001 |
| Perinatal death | 13.6 (9.6-19.0) | 6.2 (4.1-9.3) | <0.001 |

Comparisons between general and spinal anaesthesia restricted to those without preoperative haemorrhage. Perinatal deaths include stillbirth and death up to only 72 hours after delivery.

Table 4. Relationship between maternal mortality and deficit between units of blood estimated as needed and units of blood available and given.

| | 0 units | 1 unit | 2 units | 3 units | 4 units |
|-------------------|----------|----------|---------|---------|---------|
| Number of mothers | 7391 | 504 | 147 | 27 | 1 |
| Deaths n (%) | 25 (0.3) | 15 (3.0) | 25 (17) | 19 (70) | 1 (100) |

Discussion:

In this large series of caesarean sections conducted in Malawi, morbidity and mortality were high. Obstructed labour, with its serious consequences of ruptured uterus and maternal haemorrhage, sepsis and anaemia, was the principal indication for caesarean section. The incidence of ruptured uterus was surprisingly similar in urban and rural areas, showing that factors other than distance to hospital are important in the failure to manage obstructed labour. Caesarean section is feared by many from rural Africa, in the belief that it increases the risk of uterine rupture in a later pregnancy. Our results would not support this belief.

This observational study of the most common surgical procedure in Africa set out to identify potentially modifiable risk factors for this very high mortality. Combinations of small advances can have a very significant effect; in the UK the overall death rate associated with caesarean section fell from 4 per thousand in 1952-4 to 4 per 10 000 in the 1980s.¹⁰ It concentrat-

ed on whether deaths were intra-operative or on the ward, the place of training, and modifiable aspects of blood loss and anaesthetic practice.

There is little current data which address these questions in resource-poor Africa. A prospective review of operative obstetric mortality among 9833 operations carried out in Zimbabwe throughout 1992-4, revealed 22 deaths (0.22%) within 24 h of surgery, presumably mostly caesarean section.¹¹ Among the 9% carried out under regional anaesthesia, there was one death. Cause of death was haemorrhage (10), respiratory problems (6), eclampsia (3), high spinal (1), ruptured uterus (1) and gas gangrene (1). In the Zimbabwe study details of surviving women were not recorded, and the low incidence of ruptured uterus is unlike our series. The author acknowledged that, had the period of observation been longer, the death rate would have been higher. Our observation, that the majority of deaths (80%) occurred in the wards postoperatively, would support this, and possibly the most striking result is the massive predominance of deaths on the ward. This suggests post-operative ward-based care is the most important place to concentrate efforts to reduce maternal mortality even in central hospitals.

Most operations and all anaesthetics in Malawi are performed by clinical officers rather than by medical practitioners. Not all those giving anaesthetics are formally trained to do so. The lack of anaesthetic training had a significant impact on maternal mortality. Although 80% of deaths occurred postoperatively in the wards, where management is clearly inadequate, the poor

pre- and intra-operative condition of the mother is likely to have contributed.

Whilst significant blood loss was strongly associated with mortality and there was a deficit of blood in most of these cases, a deficit is no more strongly associated with mortality than blood loss alone. An equally important factor may be inadequate fluid replacement, which is relatively easy to institute even with basic facilities. This has previously shown to be associated with improved outcome in central hospitals.^{4,12} Considering the largely haemodynamic nature of the complications and causes of death as estimated by the anaesthetists, their role would seem to be important in all stages of management, though the skills needed are more in the field of basic resuscitation and good ward follow-up than in advanced knowledge of a wide variety of anaesthetic drugs or techniques.

Our results suggested that spinal may be safer than general anaesthesia for caesarean section among those without circulatory disturbance, and its use should be promoted in Africa. Spinal anaesthesia is less suitable where there is major haemorrhage, so general anaesthesia must have a place. There was little difference in maternal safety between inhalational agents used for general anaesthesia, although fetal outcome was better with ether. Thus ether, the cheaper of the two, might be a more logical choice than halothane in less wealthy countries.

Although in decline since 1968, regurgitation at induction of anaesthesia, with aspiration of stomach contents, was an important anaesthetic cause of maternal death in the UK,¹⁰ and cricoid pressure came to be regarded as a valuable means of its prevention. In the present study, however, regurgitation frequently occurred on recovery or later, when cricoid pressure could not play a role, and was associated with death only when other complications were present. Our results suggest that better training in cricoid pressure would save few lives, but passage of a nasogastric tube during surgery might be more valuable. This would lessen the danger of aspiration of stomach contents in the post-operative period, and is practised when general anaesthesia is used for emergency caesarean section in the UK. This is not the current practice in Malawi, largely for reasons of cost.

In the USA the mortality rate attributed to general anaesthesia for caesarean section between the years of 1990-5 was 32 per million operations.¹³ It is often difficult, however, to separate anaesthetic from other causes of maternal mortality. In the present series difficulty with intubation and ventilation might be regarded as direct anaesthetic deaths which we found were less frequent. Basic post-operative care was probably more important.

Observational studies have the advantage of not disturbing the measured indices, but only intervention studies can prove definitively that changes to practice lead to improvements. This study indicates some clear, and remediable areas where action might have a significant impact on maternal and perinatal mortality in a low-resource setting- good fluid resuscitation, adequate anaesthetic training, spinal anaesthesia and adequate supervision of post-operative care. Rather than highlight a possible 25-fold higher overall mortality rate for caesarean section in Malawi than in the UK, readers should bear in mind that in the present series the lives of almost 90% of women with ruptured uterus were saved, while major haemorrhage is seen much more frequently than in developed countries. It is, moreover, important to remember the tight budget constraints of most African governments. More trained anaesthetic clinical officers in Africa might have a significant impact in reducing maternal mortality by extending their management of hypovolaemic shock and other acute life threatening conditions to the wards, especially in the postoperative period.

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